Chapter Six

Biennial Assessment of the State of the Carbon Cycle Studies

6.1 Background

The continuing societal need for knowledge about the carbon cycle—to understand climate change and similar critical issues and to formulate the knowledge needed to formulate policy responses—requires an ongoing research and observation program. The outline of this program involves a permanent observing system and, while still indistinct, must be taken into account at the outset.

Continuing observational systems have a number of characteristic features:

- They are developed through scientific research, but their permanence is owed to the value they bring to society.
- The process of building these systems is a research enterprise that gradually becomes more and more operational as the science matures.
- Operational systems prove their value by providing useful information products, developed through a process that requires societal input to determine its information needs. The elicitation of societal needs requires a valuable and continuing dialog of scientists and the society they serve.
- These operational products are combinations of the observations, the models used to interpret and enhance the observations, and the data systems that make the resulting information readily and usefully available.

To maximize these systems' benefits in the area of carbon cycle science, we recommend the preparation and publication of a biennial assessment on the status of the science. This assessment would consist of two principal parts, one covering the research program, the other covering research results.

6.2 Assessing the State of Carbon Cycle Research

The biennial report would assess the status of several major areas of carbon cycle research:

- Atmospheric and oceanic observations of CO_2 and ancillary tracers.

- Process-level studies of CO_2 biogeochemistry and CO_2 anthropogenic sequestration. These studies will improve knowledge of land and ocean biogeochemistry, atmospheric and oceanic circulation, gas exchange across the air-sea interface, and enhance our ability to model all these processes.

- Modeling studies. One section of the biennial report would evaluate the current state and recent improvements of carbon cycle models and their consistent coupling to comprehensive climate models.

- Current observational approaches and sites. The report would also summarize current observational approaches and sites based on atmospheric flask samples, tall towers, aircraft sampling and aircraft campaigns, tracks of ships and drifters, ocean buoys, and transects recently occupied and planned for ocean interior studies.

6.2.1 Assessing research results

The report would assess research results in several areas:

- Recent advances in process-level understanding of biogeochemistry, atmosphere and ocean circulation, and gas exchange.

- Estimates of the anthropogenic sources and sinks of carbon for the previous biennium, including industrial output, land use changes, and purposeful sequestration rates.

- Estimates of global CO_2 fluxes between atmosphere and oceans, and between atmosphere and continental biosphere.

- Estimates of regional CO_2 fluxes between atmosphere and oceans, and between atmosphere and the continental biosphere.

- New estimates of the total global and continental-scale carbon budgets.

- Interannual variability in global and regional CO_2 sequestration rates, and their relation to physical forcing.

The biennial assessment will address the carbon cycle on a global scale, but the focus of land biosphere discussions will be North America. The assessment should be written at a level appropriate for scientists interested in the carbon cycle and climate. It should also contain a full summary, written at the technical level of a *Scientific American* article, to inform the general public and provide information useful to policy makers.

The biennial assessment will thus serve a number of purposes.

For U.S. society, it will provide baselines and future projections to compare options about how society can best address issues relating to the carbon cycle such as climate change science and impacts on ecosystem health, hydrologic systems, and human health and welfare. Continual advances made over time through the assessment would demonstrate to the public that progress is being made, providing tangible fulfillment of the social contract

the public makes to support research for ultimate social benefit. Because assessments would be regularly updated and available, they will inform the public and provide unbiased scientific information for use by decision makers at all levels considering carbon cycle issues in their policy formulation.

For the researcher, the biennial assessment will provide sources and perspectives of data not otherwise available. The biennial assessment would thus provide a step toward an ultimate climate observing system in return for the researcher's ongoing and systematic production of the assessment's inputs and products. The assessment will also give researchers a report card on how well their programs are doing and how satisfied society is with the result.

In summary, the biennial assessment will be valuable to a wide range of users, and provide a high level of reward and accountability for the carbon cycle science research community.